



DCEP Program Energy Training-Assessment Process Manual

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ANCIS Incorporated for the U.S. Department of Energy (DOE)

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1 INTRODUCTION

1.1 Energy in Data Centers

Data centers are dynamic and energy-intensive facilities. However, the rapid rate of growth in data center electricity use that prevailed from 2000 to 2006 slowed significantly from 2006 to 2016, yielding total electricity use by data centers in 2016 of about 2% of all electricity used in the US. The slower growth was driven mainly by a lower server installed base (Great Recession) rather than efficiency improvements. Figure 1 below shows the historic (black curve) and in 2006 projected (colored curves) electric energy use in data centers.

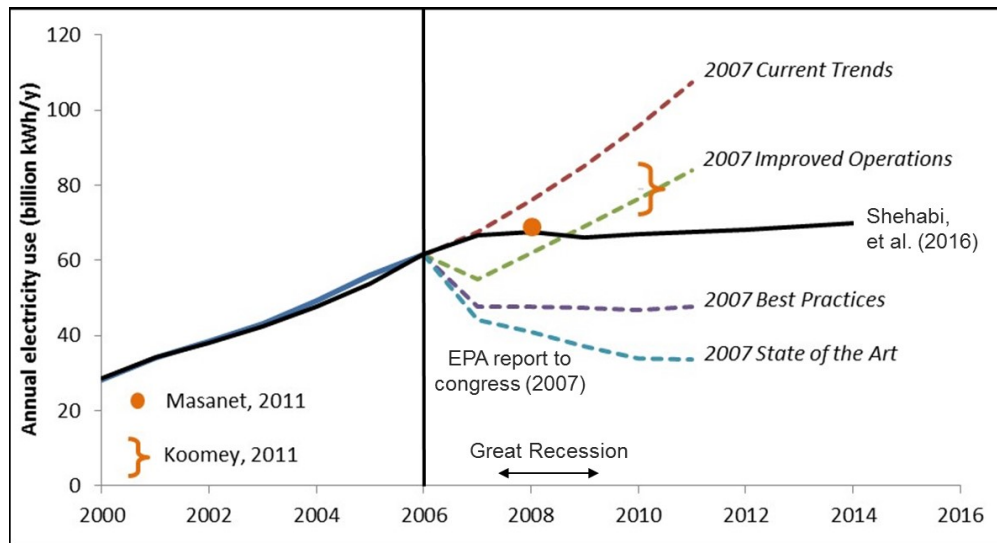


Figure 1: Historical energy use (black curve) and future energy-use projections in 2006.

1.2 Role of DOE Energy Assessments in the Process to Implement Efficiency

The DOE Data Center Energy Practitioner (DCEP) Program is driven by the fact that significant knowledge, training, and skills are required to perform accurate energy assessments for saving energy in data centers. Benefits of using the Practitioners include consistency of qualifications and approach as well as a high level of repeatability and credibility of recommendations. And, they will work with the onsite data center team through training and other means on ways to use energy more efficiently in their data centers; replication is a key goal of the energy *training*-assessment program.

Although the DOE Energy Assessment is not meant to be a traditional investment-grade audit, the assessment is designed to provide the data center industry with immediate, tangible, and sustainable results such as energy, economic, and environmental savings. A key outcome of the DOE assessment is the development of a roadmap (action plan) for progress. There are two main objectives with the DOE Energy Assessment strategy.

First, accelerate energy savings through assessments by developing an energy profile with the internal data center team, performing reviews of select data center systems (HVAC (cooling and air management), electrical power chain, IT equipment), identifying a list of

potential energy saving measures, estimating associated cost and energy savings, and documenting cost and energy savings from measures implemented.

Second, multiply savings through replication by building internal awareness and expertise. Specifically help the organization form an energy management program, create internal champions to lead energy savings efforts, and train the Site Lead in the DOE Energy Assessment Process and the use of the DOE Software Tool Suite.

The role of the DOE Energy Assessments in the overall energy-efficiency process and how the private sector consultants fit in are depicted in Figure 2. The top two (blue) blocks represent the DOE Energy Assessments (high-level profiler and in-depth system assessment tools). The next three (brown) blocks describe work by private sector consultants. Lastly, the last two (green) blocks represent savings validation and documentation by site personnel and engineering firms.

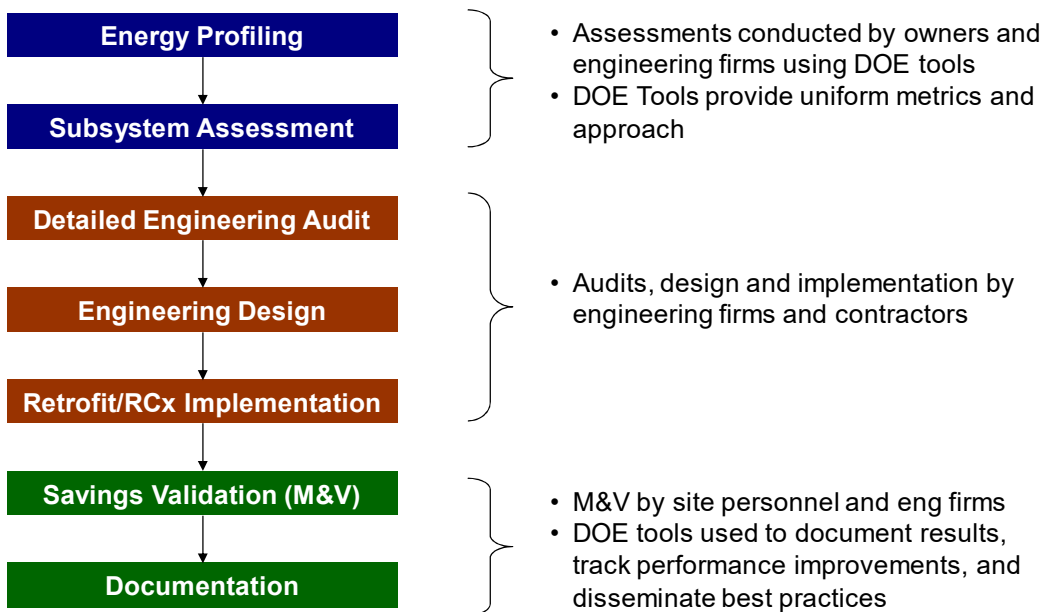


Figure 2: Overall Process for Saving Energy in Data Centers

1.3 Purpose of this Process Manual and Other Resources

This Process Manual provides administrative step-by-step instructions for conducting a DOE Energy Assessment before, during, and after the onsite assessment. Multiple appendices include useful templates for the assessments. The target audience for the Process Manual is the DCEPs. Assessment resources (documents and tools) and their descriptions are listed in Table 1. In addition, Appendix A provides useful terminology.

Table 1: Assessment Resources

Documents and Tools	Description
DCEP Process Manual (this document)	Administrative step-by-step instructions for conducting an energy assessment before, during, and after the onsite assessment.
DCEP Training PDF Slides	Program training curriculum; target audience is candidate DCEPs as well as serving as a reference for DCEPs.
Data Center Profiler (DC Pro) Tools <ul style="list-style-type: none"> DC Pro and the PUE Estimator <ul style="list-style-type: none"> User's Manual Calculation Reference Guide Training included in DCEP https://datacenters.lbl.gov/dcpro	Two early phase scoping tools to estimate Power Usage Effectiveness (PUE) without sub-metering. Free web-based tools. DC Pro provides potential PUE and tailored recommendations for improvements while the PUE Estimator only asks questions required to estimate current PUE.
Master List of Energy Efficiency Actions https://datacenters.lbl.gov/resources/data-center-master-list-energy	Comprehensive list of recommended energy efficiency actions. The list also provides DC Pro with its tailored recommendations for improvement.
Air Management (AM) Assessment Tools <ul style="list-style-type: none"> AM Tool and the AM Estimator <ul style="list-style-type: none"> User's Manuals Data Collection Guide Engineering Reference Training included in DCEP https://datacenters.lbl.gov/tools	The free Excel Air Management Tool provides recommendations for reducing the supply airflow rate and increasing the supply air temperature. The Tool also estimates % energy reduction, kWh reduction, and associated \$ savings for fans and chillers. The Air Management Estimator is a simplified version.
Electrical Power Chain Assessment Tool <ul style="list-style-type: none"> User's Manual Diagrammed power chain w/measuring points Updated UPS efficiency curve https://datacenters.lbl.gov/tools	This free Excel tool helps identify energy efficiency opportunities in the electrical power chain of a data center (transformers, generators, UPSs, power distribution units). The tool quantifies the energy and cost savings of the selected measures and calculates the payback periods.
IT Equipment Assessment Tool <ul style="list-style-type: none"> User's Manual Training included in DCEP https://datacenters.lbl.gov/tools	Forthcoming (end of 2020) free Excel tool that provides estimates of energy savings at the IT Equipment level based on user input. It estimates power (W), energy (kWh), dollar, and carbon savings.
Assessment Worksheets https://datacenters.lbl.gov/tools/3-energy-assessment-worksheets	The Worksheets can be used to collect data as well as document measurements, metrics, and actions from the assessments. The Worksheets can be especially useful if a particular software tool is not available.
Assessment Report Template and Example Report https://datacenters.lbl.gov/tools/7-energy-efficiency-assessment-report	Word template to report assessment findings as well as a real-world example. The report template can easily be filled in with actual site data.

2 PROCESS FOR DOE ENERGY ASSESSMENTS

Table 2 provides an overview of the ten assessment process steps outlined in this document as well as listing available resources. The process is broken down into four phases: Assessment Initiation (faint red), Pre-Onsite Preparation (faint blue), Onsite Activities (faint green), and Post-Onsite Activities (faint orange). The text sections following the table provide details on each of these process steps.

Table 2 is written for a third-party DCEP assessor. For an in-house DCEP assessor, the difference between on-site and off-site becomes moot.

Table 2: Overview of Process Steps

#	Process Step Description	Available Resources
1	Phase 1: Assessment Initiation Introduce the DOE Assessment Process. Identify preliminary goals, scope, onsite activities, and key personnel. Arrange for onsite logistics.	
2	Preliminary assessment by Site Lead using DC Pro or the PUE Estimator.	* DC Pro Tool(s) and Manuals
3	Phase 2: Pre-Onsite Preparation Kick-off conference call - Review scope, onsite activities, team, and logistics - Identify target systems, tools, and data to collect - Identify safety issues.	* DC Pro Tool(s) results * Target System List (App. E) * System Tool(s) and Manuals
4	Off-site compilation of information - Collect technical info from drawings, logs, etc. - Collect Site Description Survey - Collect Energy Management Practices Survey - Review required measurement equipment - Ensure functioning select DOE System Tool(s) onsite - Review Safety, Health, and Environmental Training - Review confidentiality agreements.	* Assessment Worksheets * Site Survey (App. C) * Practices Survey (App. D) * System Tool(s) and Manuals
5	Phase 3: Onsite Activities (2-3 days per System) Initiation onsite meeting with all stakeholders: - Collect participant list - Overview presentation by the DCEP - Safety, health, and environmental training - Site tour of data center - Develop detailed work plan (measurements) - Assign roles and responsibilities	* Participant Template (App. I)
6	Training to allow replication (mainly part of Step 7) - Training on selected DOE Tools - Energy management best practices	* DC Pro Tool(s) and Manuals * System Tool(s) and Manuals
7	Fundamental investigations - Field measurements - System modeling with select DOE System Tool(s) - Assessment Worksheets - Results compilation and presentation	* Assessment Worksheets * System Tool(s) and Manuals
8	Preliminary Findings Meeting - Directed to Site Management - Complete Assessment Evaluation	* Evaluation Template (App. J)
9	Phase 4: Post-Onsite Activities Compilation of Assessment and Attendance Reports - Observations and Opportunities - Estimated energy savings for each opportunity - Estimated costs for implementing each opportunity	* Process Manual (this doc) * Assessment Report Template * Master List of Actions * Assessment Report (App. B-H) * Attendance Report (App. I-J)
10	Finalize reporting requirements + Follow up - Draft to site for review - Document implemented solutions and savings.	Same as above

2.1 Phase 1: Assessment Initiation (Process Steps 1-2)

The DCEP contacts the Initial Site Contact to identify preliminary scope, onsite activities, key personnel, and onsite logistics including approximate timing of the energy assessment. The Initial Site Contact may not be the Site Lead, who is the onsite technical representative and primary person participating in the Assessment.

Step 1: Establish Preliminary Scope and Onsite Activities

The preliminary scope of the Energy Assessment should be established in this initiation phase and be refined in the preparation phase (the next phase). Sharing this Process Manual with the Site Lead may not only help communicate the overall assessment process but also establish the scope and onsite activities. The ultimate goal of energy Assessments is to provide the site with trained staff that can effectively apply the DOE Software Tools and energy management principles to investigate systems in other data centers.

Identify Site Lead

A primary point of the assessment initiation is to identify the Site Lead. This person must:

- understand the nature of the Energy Assessment
- be knowledgeable about the data center systems
- have contact with system operations and maintenance personnel
- facilitate the onsite activities, logistics, ensuring access to facilities, equipment and personnel
- be fully devoted to the Energy Assessment during the onsite period
- be responsible for learning the DOE Software Tool Suite
- be able to replicate identified system analyses.

Identify Assessment Team

The personnel who will be participating in the energy assessment needs to be identified:

- Devoted Onsite Assessment Personnel (Assessment Lead Team)
 - DCEP
 - Site Lead (the primary person participating in the assessment)
 - Other core personnel participating in the assessment.
- As-needed Personnel
 - System Operations/Maintenance Staff
 - Technical Support Staff
 - Management must participate in the Initiation Onsite Meeting (Step 5) and the Preliminary Findings Meeting (Step 8).

Arrange for Logistics

The onsite logistics tasks include the following:

- Solidify energy assessment timing; the total number of days on site depends on the number of system analyses (typically 2-3 days per Primary System)
- Arrange gate-pass for the DCEP
- Identify a conference room that can serve as an uninterrupted base
- Identify lodging issues
- Consider food services onsite to minimize lost time.

Step 2: Preliminary Assessment

The Site Lead should do a preliminary online assessment using the DC Pro Tool(s) based on available data. The DCEP will be available (off site) to assist. Besides providing an energy profile of the data center, this preliminary assessment will help with the Target Systems identification in the next assessment phase (Step 3).

2.2 Phase 2: Pre-Onsite Preparation (Process Steps 3-4)

Step 3: Kick-off Conference Call

The kick off conference call ensures that scope, onsite activities, key personnel, and onsite logistics have been identified. Other purposes are to identify the data center systems to be included in the energy assessment, technical information to be collected prior to the site visit (Step 4), and safety issues.

Target System Identification (see Appendix E)

- The activities are driven from the Target System List; data center systems targeted for the assessment. Do not allow one system to dominate the assessment. The preliminary offsite assessment with the DC Pro Tool(s) (Step 2) should provide guidance. A primary goal is to use the DOE in-depth system tools in the analyses of the target systems.
- The Primary Systems consist of the following three systems:
 - IT-Equipment
 - HVAC Systems (Cooling and Air Management)
 - Electrical Systems.

Step 4: Off-Site Compilation of Information

Collect technical information and data from surveys, drawings, logs, etc. Enter the information into selected DOE System Tool(s) or Assessment Worksheets. The Worksheets can later be used to document measurements, metrics, and actions from the assessment (Step 7). They are useful if a particular system software tool is not available. The Worksheets can be found at the following LBNL site:

<https://datacenters.lbl.gov/tools/3-energy-assessment-worksheets>

Site Description Survey (see Appendix C)

Request the Site Lead to complete the Site Description Survey to identify the *general* characteristics of the data center, see Appendix C.

- Principal data center description
 - Size
 - Type of data center (enterprise, collocation, telecom, etc.)
 - Geographic location
 - Fuel, fuel costs, and fuel unit cost.

- Primary System description
 - Type and number of equipment/systems
 - Redundancy
 - Control strategies
 - Power requirements and fuel types
 - Operating characteristics
 - Nominal operating conditions.

Energy Management Practices Survey (see Appendix D)

Also request the Site Lead to complete the Energy Management Practices Survey, see Appendix D. This survey provides high-level information on energy policies implemented at the data center.

Required Measurement Equipment

The DCEP should review the collected data and determine the existence of any data gaps for which onsite measurements or other collection methods may be necessary. Identify the measurement equipment the DCEP must bring to the site. Examples include equipment for measuring:

- Fluid (air/water) temperature
- Air Humidity
- Fluid (air/water) flow
- Electrical power.

Questions to ask the Site Lead include the following:

- Are there needs for special measurement equipment?
- Are there stationary sensors?
- What does the control system report?

Functioning Onsite DOE System Tool(s)

Ensure the selected System Tool(s) is working on a computer available to the Site Lead:

- The Site Lead should explore the Software Tool(s) as a preparatory exercise
- Download the DOE System Tool(s) from:
<http://datacenters.lbl.gov/tools>
- The DOE System Tool(s) should also be brought to the energy assessment by the DCEP in a form that allows easy access by the team (e.g., memory stick).

Review Safety, Health, and Environmental Issues and Training

Identify site-specific safety, health, and environmental issues/training:

- Identify personal protective equipment the DCEP will be required to bring
- Identify personal protective equipment the Site Lead will provide
- Identify any “special requirements”—if any
- Determine the safety, health, and environmental training requirements
- Establish a tentative schedule for safety, health, and environmental training
- Perform the training the first day of the onsite activities
- Training must be completed *and* documented before onsite activities.

Agreements

The Site Lead must provide the DCEP with the appropriate confidentiality agreements:

- Ensure the agreements are understood
- They must be reviewed, signed, and returned prior to entering the site
- The DCEP is the entity entering the agreements.

2.3 Phase 3: Assessment Onsite Activities (Process Steps 5-8)

Typically, the onsite activities take about 2-3 days per Primary System.

Step 5: Initiation Onsite Meeting

Begin the onsite activities with an initiation meeting with all stakeholders to review the assessment scope and onsite activities and to introduce the DCEP to the Lead Team.

Collect Participant List (see Appendix I)

Document the following participant information:

- Name and title
- Company
- Address
- Phone number and email address.

Overview Presentation by the DCEP

The event is an Energy *Training*-Assessment in that the Assessment Lead Team should be active participants in the assessment. Replication is a key goal of the energy assessment.

- The general framework of the energy assessment should be established.
 - Assessment scope
 - Onsite activities
 - Role of the DCEP
 - DC Pro and DOE System Tool(s)
 - Field measurement
 - Roadmap development
 - Preliminary Findings Meeting
 - Post-assessment activities.
- The energy assessment is not a fault-finding activity but an activity that is designed to:
 - Share knowledge
 - Provide tools
 - Teach energy management best practices
 - Identify opportunities for improvement
 - Identify opportunities for replication.

Safety, Health, and Environmental Training

Perform the safety, health, and environmental training identified in Step 4.

Site Tour

Conduct a brief site tour to familiarize the DCEP with the data center facility. This is an excellent opportunity to ask and answer questions.

Develop Detailed Work Plan

Develop a detailed work plan by agreeing on potential energy-efficiency opportunities to investigate, metrics to be analyzed, and Measurement Plan to be implemented. The off-site compilation of information (Step 4) should provide an excellent starting point for establishing required field measurements. The actual measurements are taking place during the Fundamental Investigations (Step 7).

Assign Roles and Responsibilities

With the Site Lead, assign roles and responsibilities among the members of the Assessment Team according to the Detailed Work Plan.

Step 6: Training of Lead Team to Allow Replication

DOE Software Tool Suite (Profiler Tool and Select System Tool(s))

While performing the onsite assessment (Step 7), the DCEP should train the Assessment Lead Team so that they sufficiently understand the DOE Software Tool analysis, including the associated data collection of required input data. It is beneficial for the Site Lead to complete some of the analysis with the DCEP, but not as the lead. At the end of the onsite assessment, the Site Lead should be able to replicate the investigations.

Energy Management Best Practices

Identification of energy management best practices is an important part of a successful Assessment. While performing the onsite assessment (Step 7), the DCEP should highlight and transfer energy management best practice knowledge to the Lead Team. Understanding the overall energy assessment process as well as energy management best practices is an excellent replication vehicle.

Step 7: Fundamental investigations

This Step is where the rubber hits the road. First, the Lead Team collects the missing information based on the data gaps identified in Steps 4 and 5. Second, selected System Tool(s) modeling is performed to quantify potential energy opportunities. The Assessment Worksheets can be useful if a particular system tool is not available. Finally, the results are compiled into a presentation directed to the Site Management.

Some missing information (data) will be readily available, including data that can be collected from building management systems, equipment read-outs (e.g., UPS), operating information, and design data. Other data collection may require measurements and temporary metering. The assessment team could decide to use a design value in lieu of a measured value, or decide to use estimates rather than actual data.

Field Measurements

Field measurements provide key input data to the System Tool(s). The detailed Measurement Plan developed in Step 5 should be applied. Ensure that all measurements required for determining critical data are performed while on site. Measurement Plan modifications are likely as the fundamental investigations proceed.

DOE System Tool Modeling

When the measurements are completed and other data have been collected, the system modeling with selected System Tool(s) should be performed to quantify potential energy opportunities. At this point, there should be no surprises regarding required Tool input data if the process outlined above was followed.

Assessment Worksheets

The Assessment Worksheets can be useful if a particular system tool is not available. The Worksheets cannot only be used for collecting data (Step 4) but also for documenting measurements, metrics, and actions from the assessment. Data from the DC Pro Tool(s) (Step 2) can be used as a starting point for the more detailed assessment. The Worksheets can be downloaded from the following LBNL site:

<https://datacenters.lbl.gov/tools/3-energy-assessment-worksheets>

Results Compilation and Presentation

The assessment results are compiled into a brief PowerPoint presentation. Preparation for the Preliminary Findings Meeting should also include discussions of presentation points with the Assessment Lead Team.

- Preliminary findings must be accepted by the Site Lead before the Meeting
 - Opportunities
 - Best practices
 - Roadmap (action plan).
- Provide a presentation with no surprises
- This should not be a fault-finding presentation.

Step 8: Preliminary Findings Meeting

The Preliminary Findings Meeting is directed to Site Management, the personnel to who the Site Lead wishes to communicate the findings.

- Present real and tangible energy-efficiency opportunities
- Identify and promote energy management best practices
- Assessment Lead Team presents the Roadmap
- Modify recommendations based on information attained during the Meeting.

Assessment Evaluation Summary (see Appendix J)

The Site Lead and other participants should complete an Assessment evaluation prior to the conclusion of the onsite activities.

2.4 Phase 4: Post-Onsite Activities (Process Steps 9-10)

The post-onsite activities are initiated by compiling the Assessment Report (CEP-R1) and the Attendance and Evaluation Report (CEP-R2). The Assessment Report is submitted to the Site Lead. The DCEP revises the draft to the satisfaction of the Site Lead. The result is the final Assessment Report (CEP-R1).

Step 9: Compilation of Assessment and Attendance Reports

Compilation of Assessment Report CEP-R1 (see Appendices B-H for templates)

The Assessment Report should be a brief narrative summary of the energy assessment. The Report should contain the following elements.

Executive Summary

The executive summary should include key observations, opportunities, and estimated energy savings.

DCEP Program Objective and Approach

Brief description of the Program objective and approach

- The objective of the Program is to provide the data center industry with technical assistance targeted to reduce energy expenditures in data centers
- The approach is for the DCEP to facilitate the completion of an energy assessment as well as provide training in the DOE Software Tools and energy management.

General information (see Appendix B)

General information includes the following:

- Data center owner
- Facility name
- Assessment dates
- DCEP name
- Data center contact with name, address, phone number, and email address.

Target Systems List (see Appendix E)

The data center systems targeted for the Assessment (Step 3). See Appendix E for a template.

Site Description Survey (see Appendix C)

The survey identifies the general characteristics of the data center (Step 4).

Energy Management Practices Survey (see Appendix D)

The survey provides a picture of the current energy management practices (Step 4).

Summary Energy Savings (see Appendix F)

A summary of the energy savings opportunities should be provided for each Primary System. See Appendix F for a template. For each Primary System, provide the following information:

- Estimate impact (\$/year and kWh/year)
- Estimate cost for implementation
- Calculate simple payback (years).

Detailed Energy Savings (see Appendix G)

Detail the energy savings opportunities in the Detailed Energy Savings Table. See Appendix G for a template. Use one table for each Primary System: IT-Equipment, HVAC Systems, and Electrical Systems. For each opportunity, provide the following information:

- Brief description
- Estimate impact (\$/year and kWh/year)
- Estimate cost for implementation
- Calculate simple payback (years)
- Identify the time horizon for completion:
 - Near-term (“N”) opportunities include improvements in operating practices, maintenance of equipment, relatively low-cost actions, or low-cost equipment purchases. Completion of the opportunity can be attained in less than one year.
 - Medium-term (“M”) opportunities would require purchase of additional equipment and/or changes in the system. It would be necessary to carry out further engineering and economic analysis. Completion of the opportunity could be attained in the one- to two-year timeframe.
 - Long-term (“L”) opportunities would require testing of a new technology and confirmation of performance of the technology with economic justification to meet corporate investment criteria. Completion of the opportunity could be attained in the two- to five-year timeframe.

Identified Actions (see Appendix H)

After the detailed energy savings, list actions required for implementing each opportunity. See Appendix H for a template. The Master list of Energy Efficiency Actions compiled by LBNL provides a comprehensive listing of actions (recommendations), see <https://datacenters.lbl.gov/resources/data-center-master-list-energy>

Roadmap

The roadmap (action plan) initially developed in Step 7 should be refined and discussed. As mentioned in the Introduction, a key outcome of the DOE Energy Assessment is this roadmap for progress.

Benchmarking

The purpose of this section is to summarize the metrics that were utilized as part of the assessment process and compare them to data from other facilities, where available.

Useful metrics may include the following:

- PUE (-)
- DCiE (%)
- Cooling Efficiency (kW/ton) [kW/kW]
- UPS System Efficiency (%)
- Rack Cooling Index (RCI)[®] (%)
- Return Temperature Index (RTI)[™] (%)

Potential Case Study

The assessment report should also discuss whether developing a case study from activities at the site is a possibility. Case studies are generally widely applicable, straightforward, and generally focus on an aspect of areas such as fundamental systems, energy management best practices, innovative solutions, and comprehensive management activities.

Compilation of Attendance Report CEP-R2 (see Appendices I and J for templates)

The Attendance and Evaluation Report includes only two listings: Attendance and Evaluation.

Step 10: Finalize Reporting Requirements

- Submit the draft Assessment Report (CEP-R1) to the Site Lead ten business days after completion of the onsite work
- The Site Lead provides review comments on the draft to the DCEP
- The DCEP revises the draft to the satisfaction of the Site Lead. The result is the final Assessment Report (CEP-R1).

Follow Up

Follow up with the site to document implemented solutions and savings.

Appendix A: Terminology

DCEP

Data Center Energy Practitioner (DCEP) is the energy expert assigned to complete the DOE Assessment; the expert serves as the facilitator for all activities

DOE

U.S. Department of Energy

DOE DC Pro Tools

DC Pro Tools include the DC Pro and the PUE Estimator

DOE System Tools

The in-depth DOE System Tools include the Air Management tool, the Air Management Estimator, the Electrical Power Chain Tool, and the forthcoming IT Equipment Tool.

Initial Site Contact

Data center representative that serves as the initial contact

Lead Team

Core personnel participating in the Assessment, including DCEP and Site Lead

Preliminary Findings Meeting

This meeting is directed to Site Management

Primary Systems

- IT-Equipment
- HVAC Systems (Cooling and Air Management)
- Electrical Systems.

Site Lead

Data center technical representative that will be the primary person participating in the Assessment

Site Management

Data center personnel to whom the Site Lead wishes to communicate the findings

Target Systems List

Listing of data center systems targeted for the Assessment.

Appendix B: General Information (Part of the Assessment Report CEP-R1)

Data Center Owner		Assessment Dates	
Facility Name		Assessment Type	
Location		DCEP Name	
Data Center Contact Information			
Name			
Address			
City/State			
Phone			
Email			

Appendix C: Site Description Survey (Part of the Assessment Report CEP-R1)

Request the Site Lead to complete the Site Description Survey to identify the *general* characteristics of the data center.

Principal Data Center Description			
Total data center area			
Electrically active area			
Type (enterprise, collocation, telecom, etc.)			
Geographic location			
Annual fuel cost (\$) and fuel unit cost (\$/kWh)	Electricity		
	Gas		
	Oil		
Primary Systems Description			
General description of key IT-equipment <ul style="list-style-type: none"> Type and number of equipment Power requirements Operating characteristics Nominal operating conditions. 			
General description of key HVAC systems <ul style="list-style-type: none"> Type and number of systems Redundancy Control strategies Power requirements and fuel types Operating characteristics Nominal operating conditions. 			
General description of key electrical systems <ul style="list-style-type: none"> Type and number of systems Redundancy Control strategies Power requirements and fuel types Operating characteristics Nominal operating conditions. 			

Appendix D: Energy Management Practices Survey (Part of the Assessment Report CEP-R1)

Request the Site Lead to complete the following Energy Management Practices Survey to identify energy policies implemented at the data center.

- Does your company have a written CEO- or Board-approved policy that includes reducing energy consumption?
☐ No ☐ Yes ☐ Unknown or no answer
- Does your company have a formal written energy management plan that is updated at least every two years?
☐ No ☐ Yes ☐ Unknown or no answer
- Does your company have a corporate or facility energy manager position?
☐ No ☐ Yes
- Do the duties of manager include finding and implementing ways of reducing the energy consumption?
☐ No ☐ Yes
- In the last two years, have there been any corporate or facility mandates to reduce energy consumption by a targeted percentage or amount?
☐ No ☐ Yes ☐ What was the percentage? _____%
- How many employees does the data center employ? _____
- Does the annual performance rating for the data center manager include a component with energy reduction goals that influence bonuses?
☐ No ☐ Yes ☐ Unknown
- In the last two years, have there been any projects in your data center to reduce energy consumption or projects that included a component aimed at reducing or managing energy?
☐ No ☐ Yes
- Were those projects a result of (check all that apply):
 - ☐ New construction
 - ☐ As a consequence of updating the data center
 - ☐ A project focusing almost entirely on energy useOn what systems were those projects focused? _____

- When you purchase new or replace equipment at the data center, does the life cycle cost, including energy use, affect what is purchased?
 - ☐ Always
 - ☐ Usually
 - ☐ Sometimes
 - ☐ Occasionally
 - ☐ Never
 - ☐ Unknown

- In managing operations and maintenance, do you analyze energy use trends to identify needed changes to operations or maintenance practices to reduce energy use?
 - ☐ No ☐ Yes

- Which financial methods does your firm typically use to evaluate energy efficiency improvements?
 - ☐ Initial Cost
 - ☐ Simple payback
 - ☐ Internal rate of return
 - ☐ Life cycle cost
 - ☐ Other (please explain) _____
 - ☐ Unknown

- What payback (*length of time*) do you normally require in order to consider an energy investment cost effective?
 - ☐ _____ (Years)

- What rate of return do you normally require in order to consider an energy investment cost effective?
 - ☐ _____%

- What discount rate do you normally use in determining the life-cycle costs of various equipment options?
 - ☐ _____%

Appendix E: Target System List (Assessment Scope) (Part of the Assessment Report CEP-R1)

The three Primary Systems are IT-Equipment, HVAC Systems, and Electrical Systems. Each Primary System, in turn, consists of key sub-systems as shown below. Check the selected subsystems for the Assessment.

Systems	Target System(s)
IT-Equipment	
Servers	
Storage	
Networking	
HVAC Systems	
Air Management	
Cooling Systems	
Chilled-Water Plant	
Electrical Systems	
UPS	
PDU	
Lighting	
Onsite generation	

Appendix F: Summary Energy Savings (Part of the Assessment Report CEP-R1)

Energy Savings Opportunity Summary				
	Impact			
Primary System Opportunity	\$/yr	kWh/yr	Cost	Payback yrs
IT-Equipment				
HVAC Systems				
Electrical Systems				
Total				

Appendix G: Detailed Energy Savings (Part of the Assessment Report CEP-R1)

Energy Savings Opportunity for Primary System: _____						
(One table for each Primary System: IT-Equipment, HVAC Systems, and Electrical Systems)						
		Impact				
#	Opportunity	\$/yr	kWh/yr	Cost	Payback yrs	N,M,L ¹
1						
2						
3						
4						
5						
:						
	Total					

Footnote 1:

N = Near-Term

M = Medium-Term

L = Long-Term

Appendix H: Identified Actions (Part of the Assessment Report CEP-R1)

Identified Actions for Primary System: _____		
(One table for each Primary System: IT-Equipment, HVAC Systems, and Electrical Systems)		
#	Opportunity	Action(s)
1		
2		
3		
4		
5		
:		

Appendix I: Assessment Participants (attendance) (Part of the Attendance Report CEP-R2)

[illegible]

Appendix J: Assessment Evaluation (Part of the Attendance Report CEP-R2)

Data Center Owner		Location	
Facility Name		Assessment Date(s)	
Individual Evaluation Summary (5 highest/likely/good, 1 Lowest/unlikely/poor)			
The program increased my understanding of my data center systems. Comments:			
The program and information learned will be useful to me. Comments:			
Will you use the DOE Software Tool Suite? Comments:			
The agenda was appropriate. Comments:			
The DCEP was knowledgeable and added value. Comments:			
Overall Comments and Suggestions:			

Resources/References

Assessment Report Template and Example Report:

<https://datacenters.lbl.gov/tools/7-energy-efficiency-assessment-report>

Assessment Worksheets:

<https://datacenters.lbl.gov/tools/3-energy-assessment-worksheets>

Center of Expertise for Energy Efficiency in Data Centers:

<http://datacenters.lbl.gov>

DCEP Training Program:

<http://datacenters.lbl.gov/dcep>

DC Pro Tools (DC Pro and the PUE Estimator):

<https://datacenters.lbl.gov/dcpro>

DOE System Tools (Air Management Tool, Air Management Estimator, Electrical Power Chain Tool, and IT Equipment Tool):

<http://datacenters.lbl.gov/tools>

Koomey, J, 2011, Growth in Data Center Electricity Use 2005 to 2010

http://www.missioncriticalmagazine.com/ext/resources/MC/Home/Files/PDFs/Koomey_Data_Center.pdf

Masanet, E, Brown, R E, Shehabi, A, Koomey, J G, and B Nordman (2011). Estimating the Energy Use and Efficiency Potential of U.S. Data Centers. Proceedings of the IEEE, Volume 99, Number 8.

Master List of Energy Efficiency Actions

<https://datacenters.lbl.gov/resources/data-center-master-list-energy>

Shehabi, Arman, Sarah J. Smith, Eric Masanet and Jonathan Koomey. 2018. "Data center growth in the United States: decoupling the demand for services from electricity use" Environmental Research Letters, Volume 13, Number 12. Dec. 18, 2018

<https://iopscience.iop.org/article/10.1088/1748-9326/aaec9c/meta>

Shehabi et al., 2016, United States Data Center Energy Usage Report

https://datacenters.lbl.gov/sites/all/files/DataCenterEnergyReport2016_0.pdf